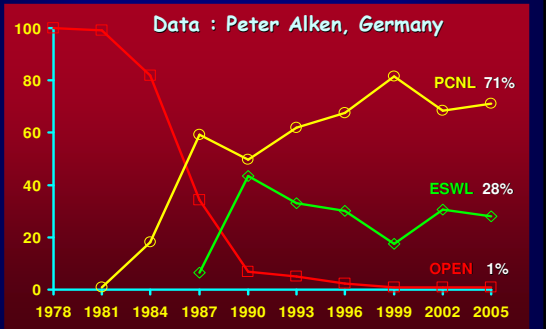
Percutaneous Nephrolithotripsy (PCNL) Tips and Tricks

EAU ESU

Anup Patel MS, FRCS (Urol.)
Consultant Urological Surgeon
St. Mary's Hospital at Imperial College Healthcare NHS Trust
London

PCNL Tips and Tricks



A Patel TCSM

PCNL Tips and Tricks

The Large Intra-Renal Stone

...esp. Hard (CaOMH, cystine), Infection or Matrix Stones!

A.Patel.TCSM

PCNL Tips and Tricks

- PCNL ideal for Polar locations - Large Renal Pelvic
- PCNL problematic in Anterior calyceal location
  - Oblique tract required Greater risk of bleeding
- PCNL painful for Upper Pole location

A Patel TCSM

PCNL Tips and Tricks

Absolute Contra-indications !

- Uncontrolled bleeding disorder
- Uncorrected bleeding diathesis
  - Anticoagulant drugs e.g. Coumadins
  - Anti-platelet drugs e.g. Clopidogrel
- Previous liver transplant and right sided stone

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

- Spinal deformity – severe kyphoscoliosis restricting access and limiting respiratory excursion
- Uncorrected medical co-morbidities
  - Diabetes
  - Hypertension
  - Renal Insufficiency
  - Anaemia

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

Complex pelvicalyceal system – narrow, long infundibulum

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

KUB IVP

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

Complex pelvi-calyceal system – short calyces = difficult access!

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

Complex stones needing multiple punctures
Complications proportional to stone bulk

A Patel TCSM

PCNL Tips and Tricks

Patient Selection is Key !

Malrotated Kidney – Tight Intra-Renal Pelvis
Little working space !

A Patel TCSM

PCNL Tips and Tricks

Surrounding Anatomy !

High kidney above 12th rib – higher incidence of injury to pleura, lungs, liver, spleen.

A.Patel,ICSM

PCNL Tips and Tricks

Follow A Step by Step Approach

Here we go! **Step One.** Take off your shirt !

A.Patel,ICSM

PCNL Tips and Tricks

Preparation

Check Team – Sub-specialist

- Multi-disciplinary
  - Urologist
  - Radiologist
  - Anesthesiologist
  - Trainees (U+R+A)
  - Trained Nurses
  - Trained Radiographer
  - Make sure everyone in OR understands
    - what you are planning to do
    - your equipment needs
    - what your back-up options are !

A.Patel,ICSM

PCNL Tips and Tricks

Take Precautions to Avoid Hypothermia

- Anaesthetic vasodilation
- Exposed body surface
- Low room temperature
- Low temperature irrigant over long time
- Impaired platelet function and enzymatic drug clearance
- Shivering increased oxygen consumption x 400%
- Myocardial ischemia and arrhythmia

Prevent by hugger bear and warmed irrigant

A.Patel,ICSM

PCNL Tips and Tricks

Patient Positioning

A.Patel,ICSM

PCNL Tips and Tricks

Patient Positions - Prone

Prone position with bolsters under lower chest and pelvis to let the ***abdominal contents fall forward***, neck support and padding of extremities

A.Patel,ICSM

PCNL Tips and Tricks

Patient Positions - Supine

- If compromised cardio-respiratory system
- Anaesthetist friendly position
- Requirement for repeated and easy airway access due to respiratory problems
- Ultrasound puncture
- Endo-camera mandatory

Courtesy of Prof. M.Desai

A Patel TCSM

PCNL Tips and Tricks

Patient Positions & Imaging
X-Ray Fluoroscopy

Lateral Flank

Modified Supine

A Patel TCSM

PCNL Tips and Tricks

Pre-Planned Staged Procedure

- Pyonephrosis
  - Acute
  - Chronic
- Gross hydronephrosis
- Renal insufficiency
- Patient with anaemia
- Patient with cystic kidney

A Patel TCSM

PCNL Tips and Tricks

Optimizing Technique

- Key requisite : Access to the collecting system.

A high flow vascular network

Vascular injury

A Patel TCSM

PCNL Tips and Tricks

Optimizing Technique

Making a Safe Puncture

- Proper pre-operative planning of all punctures and tracts

Making an Ideal Puncture

Developing a Percutaneous tract that leads straight from the skin through a papilla and the target calyx into the renal pelvis.

A Patel TCSM

PCNL Tips and Tricks

Optimizing Technique

Planning + Making a Safe + Ideal Puncture

- Assessment of relation of intra-renal anatomy with stone burden and location
- Deciding the target calyx
- Deciding the puncture plane
- Deciding the site and direction of puncture
- Controlling the puncture (depth)
- Not too medial or too cephalad
- Need parenchyma to hold access

A Patel TCSM

PCNL Tips and Tricks

Considerations before the Tract

Perform Retrograde Pyelogram

- Can be done with patient supine + flexible cystoscope (time savings)
- Allows injection of
  - Contrast + Methylene blue as needed
  - Air
- See anatomy on day of surgery
- Allows placement of ureteral catheter with Co-axial wire
  - Gives Thru & Thru wire when retrieved from above
  - Prevents fragments migrating down ureter

A.Patel,ICSM

PCNL Tips and Tricks

Optimizing Technique

Peripheral Puncture

- Respects the renal anatomy
- Offers the ***shortest trans-parenchymal access*** to the collecting system, thus minimizing renal trauma

A Patel ICSM

PCNL Tips and Tricks

Optimizing Technique

Peripheral Puncture

- Avoids the larger intra-parenchymal vessels, thus ***minimizing bleeding***

A Patel ICSM

PCNL Tips and Tricks

Optimizing Technique

Peripheral Puncture

- Preserves the close connection between the collecting system and parenchyma, thus ***avoiding extravasation***
- Uses the calyx as a part of the access tract and thus offers the widest possible and safest working space within the collecting system

A Patel ICSM

PCNL Tips and Tricks

- Assessment of the intra-renal anatomy
- Knowledge of 3-D anatomy is essential

A Patel ICSM

PCNL Tips and Tricks

X-Ray Fluoroscopic Guided Puncture

Incorrect puncture leading to difficulty advancing guide wire & false passage in kidney

Courtesy of Prof. M.Desai

A Patel ICSM

PCNL Tips and Tricks

X-Ray Fluoroscopic Guided Puncture

Correct puncture leading to easy passage of guide wire to renal pelvis and down ureter

Courtesy of Prof. M.Desai

A Patel TCSM

PCNL Tips and Tricks

Imaging for Puncture

Ultrasound Guided

- No radiation
- US guidance shows projected puncture calyx, infundibulum and pelvis are in single line
- Identifies Site, Plane, Direction and Depth of puncture
- Avoids injury to surrounding organs

A Patel TCSM

PCNL Tips and Tricks

Imaging for Puncture

Ultrasound Guided Puncture Technique

A Patel TCSM

PCNL Tips and Tricks

Subcostal Upper Calyceal Puncture

Oblique needle path leading to higher chance of bleeding

Restricted mobility of needle

Sharp angle of excursion leading to tearing of parenchyma and PCS

A Patel TCSM

PCNL Tips and Tricks

Tract Dilation Options

Single Step **Alken Co-Axial** **Serial** **Sequential**

Balloon

A Patel TCSM

PCNL Tips and Tricks

Tract Dilation Options

Cut the subcutaneous fascia adequately

Don't dilate over the safety wire !!!!

Balloon best if previous scar at puncture site

Alken co-axial dilators vs. Serial dilators

- Need floppy-tipped Stiff working wire
- Small or large track over 11Fr. obturator
- Stone occluding calyx completely

A.Patel,ICSM.

PCNL Tips and Tricks
Troubleshooting

Tract Dilation Complications

Common Problems :

- Kink the working wire
- Split neck of tight calyx
- Perforate renal pelvis medially
- Perforate renal pelvis / anterior parenchyma (4 segmental renal arteries)

Don't Push too hard & use Fluoro when advancing dilator through fascia and renal capsule !

A.Patel,ICSM.

PCNL Tips and Tricks
Troubleshooting

Tract Dilation Complications

Ensure Effective Drainage (safety-wire!!)

Antibiotics and Serial renal checks with US/CT

PCN drainage & antegrade DJ stenting

A.Patel,ICSM.

PCNL Tips and Tricks

Use of Amplatz Sheath

- Stabilizes tract
- Prevents fluid absorption
- Reduces intrarenal pressure
- Reduces fluid extravasation
- Prevents bleeding from tract during procedure
- Look out for loss of backflow from sheath !

A.Patel,ICSM.

PCNL Tips and Tricks
Troubleshooting

Lost Access !

- Antegrade safety wire down ureter before tract dilation
- Use an Amplatz Sheath !
- Get a Thru and Thru wire as soon as possible
- Place antegrade single J in ureter co-axially in Foley nephrostomy if unsure patient is stone free at end
- If all else fails, Repeat Puncture !

A.Patel,ICSM.

PCNL Tips and Tricks
Uro-sepsis Risk & Prevention

- Sterilize urine pre-operatively
  - 1 week for infected stone or renal pelvis urine (bladder urine unreliable)
- Drain obstruction 2 weeks before stone Sx
- Prophylactic i.v. antibiotics at induction
- Warmed & well hydrated patient
- Prophylactic diuretics every 90 minutes

A.Patel,ICSM.

PCNL Tips and Tricks
Uro-sepsis Risk & Prevention

- Low pressure gravity warmed irrigation
- Low Pressure access system (Amplatz sheath)
  - Instrument should be 4Fr. less than sheath size
- 5 Days oral antibiotics (3 months if staghorn)
- Perc. Drain until urine clear

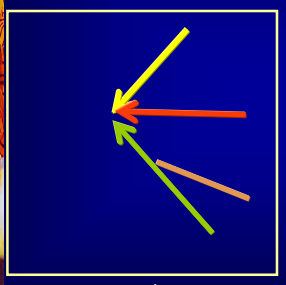
A.Patel,ICSM.

PCNL Tips and Tricks
Complex Branched Stones

Pre-op KUB Pre-op IVP

A.Patel,ICSM.

PCNL Tips and Tricks
Complex Branched Stones



Pre-plan Actual

A.Patel,ICSM.

PCNL Tips and Tricks
Complex Branched Stones

Multiple Punctures

A.Patel,ICSM.

PCNL Tips and Tricks
Complex Branched Stones

Multiple Punctures

A.Patel,ICSM.

PCNL Tips and Tricks
Complex Branched Stones

Multiple Punctures

Post-op Post-op KUB

A.Patel,ICSM.

PCNL Tips and Tricks
Comparing Single vs. Multiple Tracts

Parameters	Single Tr. (n = 207)	Multiple Tr. (n = 443)	p-value
Clearance	182 (88%)	372 (84%)	0.06
UTI	51 (24.7%)	117 (26.5%)	0.08
Blood transfusion	**18 (8.6%)**	**55 (12.5%)**	**<0.01 s**
Complications (overall)	**32 (15.9%)**	**106 (24%)**	**<0.001 s**
Major complications	**9 (4.6%)**	**22 (5%)**	**0.92**
Hospital stay (days)	7.4 (mean)	11.1(mean)	<0.001 s
Analgesic requirement	3.1 (mean)	4.4(mean)	<0.001 s
Leak (days)	1.3 (mean)	1.5(mean)	= 0.01 s

A.Patel,ICSM.

PCNL Tips and Tricks
Bleeding Risk Factors

- Drugs
- Blood problems leading to coagulopathy
- Long operation time
- Large stone burden
- Multiple punctures
- Renal pelvis perforation
- Large tract size relative to size of infundibular neck
- Large excursion with rigid instruments
- No pre-existing nephrostomy tract
  - Esp. if infected or obstructed system

A.Patel,ICSM.

PCNL Tips and Tricks
Bleeding : Arterial or Venous

Arterial bleed	Venous bleeding
• Severe	• Not so severe
• Continuous bleeding with clots	• No significant hypotension; if so, temporary
• Sudden hypotension not improving with conservative management	• Generally self limiting

A.Patel,ICSM.

PCNL Tips and Tricks
Dealing with Bleeding Tracts

Balloon 1-step dilation + sheath
- More xpensive but Better Tamponade
  - 10% Tx risk vs. 25% for Amplatz dilation

Severe bleeding during access
- Difficult to achieve tamponade with any catheter if stone still filling calyx
- Send blood for X-match
- Rapidly break stone in calyx and advance sheath for tamponade without angulation
- Place large bore Foley or Kaye Catheter
- Flowseal, Tachoseal etc
- Bed rest and Monitor serial hematocrits
- Angiography & sub-selective embolization
- Open Sx + gortex bolsters + sutures

A.Patel,ICSM.

PCNL Tips and Tricks
Dealing with Delayed Bleeding

- Usually due to vascular arterial injury

Arteriogram and selective or sub-selective embolization

Pseudo-aneurysm

A.Patel,ICSM.

PCNL Tips and Tricks
Managing Injury to Adjacent Organs

Lung, pleura, liver, spleen, pancreas, large & small bowel, vessels

- Recognize injury early
- Terminate procedure
- Appropriate therapy directed at injured organ
- Antibiotics & Supportive measures
- Drain
- Repair
- Defunction
- Remove part or whole

A.Patel,ICSM.

PCNL Tips and Tricks
Contact Energy Sources

Ultrasonic, Electrohydraulic, Pneumatic, US + Pneumatic, Holmium

A.Patel,ICSM.

PCNL Tips and Tricks

Energy Sources

Universal Deflectible Energy Source for Flexible Endoscopes

A.Patel,ICSM

PCNL Tips and Tricks

Preventing Damage from Energy Sources

- Know thy energy sources and be careful with them ……don't hit a pedestrian or there will always be a dent in your Mercedes !
- Full visual control of operative field mandatory before discharging energy source
- Lithoclast (Very safe even for the beginner)
- Suction-US 9Fr. Probe (Pretty safe)
  - Clogging overheating thermal injury delayed strictures
- Lasers (Tunable dye & Holmium)
  - High safety profile – pinhole perfs. managed by DJ stent
- EHL (0-10%) (More dangerous)
  - Perf. PCS / Ureter managed by DJ stent drainage +/- Foley

A.Patel,ICSM

PCNL Tips and Tricks

Preventing Pain

- Avoid punctures near ribs and thru diaphragm
- Use small size nephrostomy tubes in general, esp. near ribs
  - If necessary, use 2nd puncture in Lower Pole for larger bore drainage in combination with small nephrostomy in upper pole
- Avoid nephrostomy tubes altogether – Tubeless !
  - Small stone burden <3cm
  - 1 tract vs. multiple tracts
  - No distal obstruction
  - No complications during procedure
  - No secondary PCNL needed
  - Operation time <2 hours
  - No tract bleeding (fulguration or Flo-Seal)

A.Patel,ICSM

PCNL Tips and Tricks

Retained Stones

- Inside or Outside the collecting system ?
- Extra-renal stone loss
  - Prevent by sizing fragment to size of sheath lumen
  - Get assistant to steady sheath during extraction or suture to skin
  - CT to avoid unnecessary salvage procedure if previous surgery
- SIRF's > 3mm
- If suspect or unsure, 5 Fr single-J down ureter co-axially inside large bore Foley nephrostomy tube
  - Mature track and go back down track to fragment/remove
  - Flexibles, EHL- Laser (200 or 365μm) + Nitinol accessories
  - RIRS salvage
  - Pass the Ball !
  - Sedation or no anesthesia

A.Patel,ICSM

PCNL Tips and Tricks

Management of Bowel Injury

- Colon at Risk if :
  - » Left renal disease
  - » Chronic constipation
  - » Other cause for distended descending colon
  - » Previous abdominal surgery
  - » Hypermobile kidneys and lower pole stick
  - Avoid by prone CT (deep insp and exp) or real time US guidance
  - Conservative management if small and extra-peritoneal
    - » DJ stent, bladder Foley, Triple Abx and slow withdrawal nephrostomy tube into colon and then at interval from colon after 5 days for established tract to form
  - Aggressive management with open surgery (repair and defunction) if
    - » Intraperitoneal perf.
    - » Delayed diagnosis

A.Patel,ICSM

PCNL Tips and Tricks

Patient Selection is Key !

A.Patel,ICSM

PCNL Tips and Tricks

- Body habitus precluding safe access
  - Morbidly obese patient
    - Try in lateral flank position as bulk of fat falls forward
    - Longer instruments from certain manufacturers

Courtesy of Prof. G.Preminger

A.Patel,ICSM

PCNL Tips and Tricks

How to prevent subcutaneous sheath placement

1. Use extra, extra long sheath
2. Place sutures on sheath
3. Place clamp on sheath
4. Perform PNL without sheath

   (only as last resort !)

A.Patel,ICSM

PCNL Tips and Tricks

Scope Technology Evolution

A.Patel,ICSM

PCNL Tips and Tricks

Scope Technology Evolution

A.Patel,ICSM

PCNL Tips and Tricks

Complications	5-34%
Bleeding	1-26%
Secondary Bleeding	0.3-1.5%
Transfusion	2-25%
Embolization	0.3-1%
Open Surgical Salvage	0-1.8%
Lung Injury	0.1-100%
Supra 12th rib	1-14%
Supra 11th rib	23-100%
Bowel Injury	0-2.8%
Infection	1-29%
Septicemia	<3%
Death	0-1.1%

A.Patel,ICSM